CGS IN 250

# Cosmic Visions:
## The Science of Astronomy and the Arts


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| Instructors: | Andy Andres | Charles Henebry | Time: Tue 6:30-9:15pm |
| Office Location: | CGS 303A | CGS 319A | Classroom: CGS 313 |
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| Office Hours: | Tue 5:30-6:30 | Tue 5:30-6:30 | |


**Course Description**

How has stargazing shaped our understanding of the world and our place within it? How have changes in our conception of the universe altered our understanding of human nature—and vice versa? While we tend to conceptualize art and science as separate spheres, astronomy has always been interwoven with culture, and artists and astronomers continue to draw inspiration from one another even today. This team-taught course traces the shared, often symbiotic, history of these two ways of knowing and exploring the cosmos. Combining scientific instruction with discussion and analysis of literature, the visual arts, music, and theater, the course culminates in creative artistic projects that draw on astronomy and the history of human stargazing.

We will examine three distinct phases in scientific understanding: the earth-centered systems of the Ancient Mediterranean and Central America, the sun-centered system developed in sixteenth- and seventeenth-century Europe, and the radically uncentered, infinitely expanding universe of twentieth-century science. Students will observe the apparent motion of heavenly bodies across the sky, and will learn how that motion was explained in antiquity—as well as how it was harnessed for the creation of calendrical time. Students will make telescopic observations of the moons of Jupiter, and grapple with the paradigm shift of Copernicus, Galileo, and Newton. Finally, students will learn about Hubble's use of spectroscopy and red shift observations in the development of the Big Bang Theory.

In connection with these distinct phases, or *epistemes,* we will examine ancient astronomical artifacts, calendrical systems, the Music of the Spheres, the Great Chain of Being, early and more recent science fiction, Romantic-era stargazing, and twentieth-century avant-garde music and art.

**Scientific Inquiry I**

*Learning outcome: Students will identify and apply the major concepts used in the natural sciences to explain and quantify the workings of the physical world. This will include an introduction to the way that scientists explain complex systems such as living organisms, the Earth, or the Universe.*

- Students will observe the diurnal and long-term apparent motions of the sun, moon, stars, and planets. Students will employ the astronomic models of three distinct eras (Antiquity, the seventeenth century, and the twentieth century) to explain the apparent motion of heavenly bodies. They will engage in naked eye astronomical observations, and they will learn about the use of telescopes, as well as the wide array of more advanced equipment used by astronomers today. Through close study of the Copernican Revolution, students will grapple with the processes through which scientists entertain new theories and (sometimes) reject old

ones—resulting in significant changes to our understanding of the universe and of our place within it.

**Writing Intensive**

*Learning outcome 1: Students will be able to craft responsible, considered, and well-structured writing that is appropriate to genre, intended audience, or rhetorical situation.*

- In both formal and informal writing assignments, students will discuss the influence of astronomy on the art and culture of the past and the present. They will craft a rhetorically persuasive Grant Proposal. And they will create a work of art (visual, musical, spoken-word, or multimedia) that responds to astronomical lore of the past or present, writing about their process in an artist's statement.

*Learning outcome 2: Students will be able to read and interpret texts, data, media, etc. with understanding, engagement, appreciation, and critical judgment.*

- Students will engage with a wide variety of texts, not just astronomical textbooks and histories, but works of literature, music, and the visual arts. They will attend to genre, noting how it shapes reader expectations and finds expression in style, texture, and color. They will be encouraged to read not merely for information but for tone and rhetorical mission, distinguishing satire from starry-eyed enthusiasm, and god-fearing devotion from agnostic empiricism.

*Learning outcome 3: Students will be able to write clearly and coherently in a range of modes and styles, integrating graphic, multimedia, and other elements as appropriate to the genre.*

- Students will write in response to a variety of prompts, for a total of 16 pages of graded work. They will draft and revise a 4p grant proposal requesting funding for a scientific, artistic, or educational project touching on Astronomy. They will also draft and revise two 3p fieldwork reports. The semester will culminate in a final artistic project consisting of an artwork and an 2p artist's statement. Each of these four assignments will also be accompanied by an ungraded metacognitive reflection. Total graded work: 2 fieldwork reports (4p total), 4p essay, 4p grant proposal and 2p artist statement = 14p. All pages inform final writing:
    1. Low-stakes homework, scored for completion:
        a. short responses to Astronomy lectures, commented for clarity and concision as well as the student's grasp of the science.
        b. 1-2 written weekly in response to a reading/viewing/listening HW assignment, and turned in as a public comment on the course website. These will serve as jumping-off points for class discussion and for the short essay due near the end of the semester.
        c. draft work and metacognitive reflections for the grant proposal, artist's statement, and experimental fieldwork.
    2. Medium-stakes work, graded for quality:
        a. two 2p experimental fieldwork reports
        b. one 4p essay, revised and expanded from HW submission
    3. High-stakes work, draft and revision:
        a. 4p grant proposal
        b. 2p artist statement, written to accompany the art project
- Students will receive feedback on all written work. Conferences between students and instructors will provide additional feedback, with a particular focus on the sequence of assignments leading up to high-stakes work.

**Creativity and Innovation Toolkit**

*Learning outcome 1: Students will demonstrate understanding of creativity as a learnable, iterative process of imagining new possibilities, through revision and metacognitive reflection.*

- Students will work iteratively on the Art Project, Grant Proposal and Fieldwork assignments (described below), producing drafts for critique both in class and via instructor feedback.
- Students will write metacognitive reflections to accompany their draft work, as well as their final products.

*Learning outcome 2: Students will be able to exercise their own potential for engaging in creative activity by conceiving and executing original work either alone or as part of a team.*

- Students will exercise their creativity in three distinct types of assignment:
    1. The Art Project calls for students to envision and complete a work of art which draws inspiration from Astronomy. This is an open-ended creative challenge.
    2. The Grant Proposal calls for students to envision and propose an exhibit, performance series, or educational program designed to promote public interest in Astronomy and space exploration. Students will apply principles of design, identify challenges and work within constraints.
    3. Fieldwork assignments challenge students with unstructured, ill-defined problems: either an experimental quandary (where best on campus to document sunset on the Autumnal Equinox) or an unruly data set (telescopic images of Jupiter's moons).

**Prerequisite:** WR120 or its equivalent.

**Course Pedagogy**

This team-taught course brings together faculty from the Natural Science and the Rhetoric Divisions of the College of General Studies. Both professors will be on-site for the entirety of each class. Classes will run in the evening, once weekly for three hours, with each session devoted to a variety of educational strategies:

- Lecture-style presentation of key concepts from science and philosophy, broken up by active learning as described below.
- Active learning promoted through short in-class writing assignments followed by peer-to-peer discussion—leading in turn to whole-class discussion as described below.
- Whole-class discussion of scientific discoveries and their impact on the arts—as well as the influence of art, culture, and society in shaping scientific inquiry and discovery.

Outside of the classroom we will draw on a variety of experiential learning strategies:

- sidewalk stargazing during class sessions
- Stellarium (link), an online planetarium app
- fieldwork assignments requiring astronomical measurements

Creativity and Innovation will be taught using the vocabulary of "design thinking," a nonlinear process for grappling with complex practical and conceptual problems. The process highlights five steps:

- Understand: outline the problem and get acquainted with previous efforts to solve it.
- Empathize: consider the audience for whom you're crafting a solution.
- Ideate: challenge assumptions and formulate new ideas.
- Prototype: draft a trial run of your solution.
- Test: take the solution for a test drive, get outsider feedback.

This five-step process should be repeated iteratively, until the solution is “ready for prime time.”

**Textbooks** (note: not required to purchase, see link below or BlackBoard)

Stephen Fabian, *Patterns in the Sky: An Introduction to Ethnoastronomy*, Waveland Press (2001).

Andrew Fraknoi, David Morrison and Sidney Wolff. *Astronomy 2e*
Publisher/website: OpenStax (Mar 9, 2022) Houston, Texas.
https://openstax.org/books/astronomy-2e/pages/1-introduction

**Courseware**
https://cosmicvisions.commacafe.org

**Assignments and Grading Criteria**
- Weekly Astronomy In-Class Activities: 5%
- Weekly Arts HW (short answer): 5%
- 2x fieldwork write-ups (2p + metacognitive reflection): 10% total
- Essay on one of the weekly Arts Readings (4p): 5%
- Grant proposal (4p + metacognitive reflection): 15%
- Class participation: 5%
- Midterm and Final Exam: 20% each
- Art project (accompanied by a 2p artist’s statement + metacognitive reflection): 15%

**Accommodations**
Students needing academic accommodations must contact the Office for Disability Services (353-3658)

**Resources/Support**

**Educational Resource Center**
*One-on-one peer tutoring, study skills help, and writing assistance.*
100 Bay State Road, 5th Floor
(617) 353-7077 | www.bu.edu/erc

**CGS Writing Center**
*Schedule an appointment at the reception desk of the Writing Center*
CGS room 330B, 3rd Floor (back of the Katzenberg)
Monday–Thursday: 10-4 | Friday: 10-1

**CAS Writing Center**
*On a walk-in basis, unless also in WR.*
100 Bay State Road, 3rd Floor (617) 358-1500
www.bu.edu/writingprogram/the-writing-center/

**A Scholarly Community: Course Dogma and University Policies**
- Professors Andres and Henebry are responsible for introducing key concepts.
- Students are responsible for engaging with that material both in class and during fieldwork.

- Collectively, we form a "Cross-Disciplinary Think Tank." Scholars and artists working in communities tend to produce more innovative art and research, because their work is inspired and enlivened by other disciplines' modes of thought. You will share findings with others by posting your HW and finished projects on the course website.
- Attendance & Absences: to facilitate the interchange of ideas, it's vital that you miss as few classes as possible. Absences are particularly a problem when there are only 14 class meetings. Any absences will be penalized on the final grade. Allowance will be made for major illness and religious observances.
- Assignment Completion & Late Work: all assignments will be turned in through the course website. Late work will be penalized, unless cleared with the professor beforehand.
- Electronics: bring your laptop to class so you can access your writing and other course materials as needed. Keep your laptop closed at all other times. Keep your phone in your bag or pocket.
- Plagiarism and other forms of academic dishonesty, like the misrepresentation of data, are grave offenses in this course, at BU, and in the wider world of historical research. Incidents of academic dishonesty violate the trust of the scholarly community, and formal charges will be pursued. Plagiarism includes but is not limited to (1) copying or restating the work or ideas of another person in oral or written work performed for course credit without citing the appropriate source or (2) collaborating with someone else in an academic endeavor without acknowledging his or her contribution. Misrepresentation or falsification of data includes but is not limited to (1) citing authors that do not exist, (2) citing interviews that never took place, and (3) citing field work that was not completed.
- In this course, limited use of artificial intelligence (AI) is permitted for specific assignments or within set parameters as follows:
  - Any student work submitted using AI tools should clearly indicate what work is the student's work and what part is generated by the AI. In such cases, no more than 25% of the student work should be generated by AI. If any part of this is confusing or uncertain, please reach out to your professors for a conversation before submitting your work.
  - Using an AI-content generator such as ChatGPT to complete an assignment without proper attribution violates BU's Academic Conduct Code, specifically the Plagiarism Section. By submitting assignments in this class, you pledge to affirm that they are your own work and to attribute your use of any tools and sources.
  - To ensure academic integrity, students must openly disclose any AI-generated material they utilize and provide proper attribution, including in-text citations, quotations, and references.
  - To indicate the use of an AI tool, a student should include the following statement in their assignments: "The author(s) acknowledge the utilization of [Generative AI Tool Name], a language model developed by [Generative AI Tool Provider], in the preparation of this assignment. The [Generative AI Tool Name] was employed in the following manner(s) within this assignment [e.g., brainstorming, grammatical correction, citation, specific section of the assignment]"
  - How to cite generative AI output (MLA)
  - How to cite generative AI output (APA)
  - How to cite generative AI output (Chicago)

*http://www.bu.edu/academics/policies/academic-conduct-code/*

## Calendar of Assignments *(HW assignments are listed in the space between class sessions)*

**Pre-Class Astronomy Reading**
Carl Sagan, "Science as a Way of Thinking": link.
Openstax Astronomy (pdf | online), Chapter 1 and Chapter 2.1.
Fabian *Patterns In the Sky*, selections: link.

**Pre-Class Arts Reading**
Two creation myths: Genesis 1:1–2:4; the Eskimo tale of sister sun and brother moon. *WIN:* 1-2 response.

### Week 1: Sun, Crops, Life

*Astronomy:* Introduction to the Scientific Method (observation and theory) and to Naked Eye Astronomy. The apparent motions of the Sun and Moon. The phases of the Moon.
*The Arts:* Calendars and primitive agriculture. Stonehenge and Newgrange.
*WIN:* Evoking detail as grist for analysis.

**Fieldwork Assignment: Autumnal Equinox trial run**
Document the sun setting from a position on campus using your cellphone camera. 1p reflection: how might you improve data collection in preparation for documenting the Autumnal Equinox next week?

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 2 and 4.1-4.4.
Magli, selections from Ch 8: Egypt

**Arts Reading/Viewing**
Matthew 1:18–2:12 (the Nativity); four artifacts from antiquity. *WIN:* 1-2¶ response.

### Week 2: Fixed Stars and Wanderers

*Astronomy:* Stars, planets, comets, novas, and shooting stars as observed by the ancients. Greek astronomy under the influence of Plato: Eudoxus, Aristotle.
*The Arts:* Egyptian art and mythology of the sun. The Nativity Star.
*CRI:* Design Thinking: a five-step process, leading into Mars calendar creative group exercise. Peer discussion of fieldwork trial run.

**CRI: Preliminary Meeting with Prof Henebry**
Creative semester projects introduced: small group brainstorming.

**Fieldwork Assignment: Autumnal Equinox data processing trial run**
Using a photograph of the setting sun as reference, mark on a local map your position as well as the direction of the sun. 1p reflection: how confident are you in these findings? How might you use landmarks in the photographs to improve the accuracy of your findings?

**Astronomy Reading**
Openstax Astronomy (pdf | online), re-read Chapter 2.2 and 2.3
Biography of Ptolemy
Magli, selections from Ch 10: Greece and Rome.
Viewing the Roman Pantheon.

**Arts Reading**
Virgil, *Aeneid VI,* 836-869. *WIN:* 1-2¶ response focusing on Virgil alone or comparing to Matthew 1:18–2:12.

### Week 3: Ptolemy's Epicycles and Equant

*Astronomy:* Ptolemy's answer to Plato's problem. Philosophies of science: idealism vs. empiricism.

*The Arts:* the role of the Heavens in Roman politics. Caesar's Comet and the Pantheon.

**Astronomy Reading**
Openstax Astronomy (pdf | online), re-read Chapter 2.4.
MacTutor, "Biography of Copernicus."
Stanford Encyclopedia of Philosophy, "Biography of Copernicus."

**Fieldwork Assignment: Autumnal Equinox data collection**
Document the sun as it dips below the horizon on the Autumnal Equinox (Sep 22, 2025) to define true West. *In case of cloudy weather, perform this experiment on an evening shortly after the equinox.*

**Arts Reading/Viewing: Renaissance Astrology**
Georg Pencz ,"Seven Planets"; Shakespeare, Sonnet 14. *WIN:* 1-2¶ response.

## Week 4: The Copernican Revolution

*Astronomy:* Copernicus' Model; Brahe's Observations.
*The Arts:* Renaissance Astronomy emerges from the Pseudoscience of Astrology.
*CRI and WIN:* Peer feedback on equinox draft/trial run.

**Fieldwork Assignment: Autumnal Equinox final**
3-p writeup of your Autumnal Equinox fieldwork, including annotated photographic data and a map showing the direction of the sun as it set. Your writeup should detail both experimental procedure and data processing, and should conclude by meditating on the accuracy of your results—and how they might be improved upon if you were to repeat the experiment next year.

**Astronomy Reading**
Openstax Astronomy (pdf | online), re-read Chapter 2.4 and read Chapter 3.1.
Impey, Ch. 3.4-3.9 ("Tycho Brahe" to "The Trial of Galileo").

**Arts Viewing**
Bertolt Brecht, *Life of Galileo. WIN: 1-2¶ response.*

## Week 5: Kepler and Galileo

*Astronomy:* Kepler's debt to Brahe's observations. Galileo's telescopic observations, Jupiter's moons, Venus' phases.
*The Arts:* Bertolt Brecht's saint of reason, Galileo. Introduction to Milton's universe.
*WIN:* The rhetorical situation of a grant proposal: How to Ask for Money.

**DUE:** Draft of grant proposal (*CRI and WIN:* students will receive instructor feedback within two weeks).

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 3.2-3.5.
Impey, Ch. 3.10-11; 3.13 ("Isaac Newton", "Newton's Law of Gravity", and "The Birth of Modern Science").

**Arts Reading**
Satan's celestial journey in Milton's *Paradise Lost,* book 4. *WIN: 1-2¶ response.*

## Week 6: Newton's Laws; Halley's Comet

*Astronomy:* Rival theories: Cartesian Vortices and Newtonian Gravity.
*Arts:* Satan's epic voyage through the universe.
*CRI:* preliminary look at the body of evidence available for the Galileo's Moons fieldwork.

***CRI:* Fieldwork Assignment: Galileo's Moons preliminary**
From a collection of 15 images of Jupiter and its moons, select 3-4 that tell a story of the moons' motion relative to Jupiter. Consider whether you get better results from hour-by-hour photos or from day-by-day photos. Write a 1-p metacognitive reflection on how you might present this data, visually, to maximum effect.

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapters 7-10.

**Arts Viewing**
Naysmith and Carpenter: lunar photographs c. 1865; Paris Observatory: lunar photographs c. 1895. *WIN: 1-2¶ response.*

## Week 7: Intro to the Solar System, the earth, Moon and Rocky Planets

*Astronomy:* Physical properties of the inner planets.
*The Arts:* Nineteenth century lunar photography.
*CRI and WIN:* presenting a viable plan of action in a grant proposal.

***CRI:* Final Project preliminary**
Meet with Prof Henebry or Andres during office hours to discuss plans for the FInal Project. Tell us what you plan to create.

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 11.

**Arts Reading/Viewing**
George Griffith, "A Visit to the Moon"; Georges Méliès, *A Trip to the Moon*. *WIN: 1-2¶ response.*

## Week 8: Midterm Exam + Gas Giants

*Astronomy:* Herschel observations yield Uranus, Le Verrier's calculations yield Neptune.
*The Arts:* Early science-fiction travel to the moon and beyond. Imperialism and the call to adventure.
*CRI:* peer discussion of Galileo's Moons preliminary. Strategies for data visualization.

**Fieldwork Assignment: Galileo's Moons final (CRI and WIN)**
3-p writeup of your Galileo's Moons fieldwork, including annotated photographic data documenting the moons' motion relative to one another. Your writeup should detail the procedure you followed in processing the data, and should conclude by meditating on how your results might be improved upon.

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 5.

**Arts Reading**
HP Lovecraft, "The Color Out of Space" and the opening passage from "The Call of Cthulhu." *WIN: 1-2¶ response.*

## Week 9: Properties of Light

*Astronomy:* Blackbody radiation, line spectra, and the Doppler Effect; the composition of stars.
*The Arts:* Cosmic horror and modern science.

**DUE:** Grant Proposal *(CRI and WIN)*

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 17-18, 21-22.

**Arts Viewing**
Space film: *2001 a Space Odyssey. WIN: 1-2¶ response.*

## Week 10: Stellar Astronomy

*Astronomy:* Stellar evolution. The Main Sequence.
*The Arts:* Hal's pitiless logic and the zero-sum game of superpower rivalry.
*WIN:* the rhetorical situation of the Artist's Statement.

**DUE:** draft of the Artist's Statement *(WIN)*

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 23-24.

**Arts Reading**
Larry Niven, "Neutron Star." *WIN: 1-2¶ response.*

### Week 11: White Dwarfs and Black Holes, Planets Around Other Stars

*Astronomy:* The formation of planetary systems. Extrasolar planet surveys and the discovery of exoplanets. The Fermi Paradox and the Drake Equation.
The mind-bending power of gravity. Cold-War Science Fiction.

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 25, 26, 28.

**Arts Viewing/Listening**
Space Art: Chesley Bonestell, John Harris; Space Music: Vangelis, John Serrie. *WIN: 1-2¶ response.*

### Week 13: Galactic Astronomy

*Astronomy:* The Milky Way, galactic structure, galaxy types.
*The Arts:* Selling space exploration with Bonestell's and Harris' futuristic visions. Listening to infinity in the music of Vangelis and others.

**Astronomy Reading**
Openstax Astronomy (pdf | online), Chapter 26.5 and 29.

**DUE:** Final Arts Project (Artwork + Artist's Statement: *CRI and WIN)*

### Week 14: The Universe

*Astronomy:* Hubble and the Red Shift, the Big Bang, the Cosmic Microwave Background and the structure of the visible Universe.
*CRI:* Presentation of final projects.